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Community structure and diversity of a tropical dry deciduous forest of Hastinapur region, India

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Abstract: The present study deals with quantitative analysis of vegetation of forest area in Hastinapur, India. A total 3 sites were selected for the study. The values of density and total basal area for different species ranged from 0.5 Ind100m^{-2} to 2.2 and 16.50 cm^{2}tree^{-1} to 1055.0cm^{2}tree^{-1}. Most of the species on different sites were randomly and regularly distributed, none of the species were found with contagious distribution. The values of Cd and H' were ranged from 0.003 to 0.035 and 0.000 to 0.014.

Keywords: Community structure, Distribution pattern, Concentration of dominance, Species diversity.

INTRODUCTION

Hastinapur region of North West Uttar Pradesh is part of north upper Gangetic plain. The whole region is tract of various classes of fertile soil. The vegetation in the Gangetic plain is generally of tropical dry deciduous type, which is degraded to open scrub jungles because of population pressure, extensive agricultural practices and extensive felling of trees due to human interference. Besides this change in environmental conditions, the vegetation reflects changes in its structure, density and composition (Gaur, 1982). The most important structural property of a community is a definite quantitative relationship between abundant and rare species. The study of floristic composition and phytosociological attributes are useful for comparing one community to the other from season to season and year to year (Singh, 1976). Species content and their ecological amplitude determine structure and nature of plant community. This includes the investigation of species composition and sociological interaction of species in communities (Muller-Dombois and Ellenberg, 1974). The chronic form of disturbances occuring in forest adversaly influence the succession, growth and surviva of seedlings and sapling. Regenration in many indian forest is inadequate to replace the adults (Sukumar *et al.*,1992). conservation of thse forest will depand on an understanding of forest ecosystem dynamics (Sussman and Rokotozfy, 1994).

Soil is a medium of all plant productivity. The vegetation influences the physical and chemical properties of soil to a great extent. It improves the soil structure, infiltration rate and water holding capacity. Das *et al.*(1980) showed that the nature and content of organic debris returns to the forest floor varying with vegetation affecting the physic-chemical properties of soil from the direct impact of raindrops thereby controlling erosion and increase the moisture status of the soil.Several studies have been undertaken on community structure and organization in natural forest in different climatic zones of india by different workers Chandra (1996), Kumar and Kumar (1997), Varghese and Menon (1998), Shadangi *et al.*(2000), Pande (2001),Sagar *et al.* (2003), Kumar *et.al.*(2005), Sanjeev *et.al.*(2006). Anthropogenic factors regularly affects the diversity and structurer of forest so it became necessary to study forest as per their quantitative characters so that its future pattern can be predicted.

MATERIALS AND METHODS

Study area: The present study was carried out in natural forest of Hastinapur 36.4 km north east to Meerut district. It lies at 29^{0} 1' N latitude and 77^{0} 9' E longitudes and has an elevation of 215 mt above the sea level. The area receives an average annual rain fall of 760 mm to 890 mm mainly concentrated during the period of July- September. In summers the maximum temperature rises up to 42^{0}C and the minimum temperature falls down to 2^{0}C in the cold frosty nights of December and January. The vegetation is at its zenith during the rainy season because of high humidity and moderate temperature.

Sampling method and collection of data: The field study period extended over the months of July-November 2004. Three sites were selected for the present study (Hillock, Block-1 and Block-2) of these hillock was highly disturbed while Block-1 was moderately disturbed and Block-2 was least disturbed. A walk through survey was carried out to get a picture of the entire vegetation falling under the study area. The size and number of the quadrate were determined by were determined by species area curve method. The number of quadrats against the number of species (Mishra, 1968). Total 30 quadrate of 10×10 m for

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trees and 60 quadrates of 2×2 m (within 30 quadrats of 10×10 m) were randomly placed for seedlings, saplings shrubs and herbs. In every quadrat data on name of species cbh (circumference at breast height) were recorded for all the species.

Soil analysis : The soil characteristics were evaluated by collecting three soil samples at different depth *i.e* horizon A (0-10cm) horizon B (10-20 cm) horizon C (20-30 cm) in the studies forest sites, were analyzed for the physic chemical properties of the soil. Soil reaction was assessed by a control dynamic digital pH meter. The organic carbon percentage was determined by Walkley and Black's rapid titration method (Walkley and Black, 1934). Available phosphorus was determined by phosphomolybendenum blue calorimetric method (Jackson, 1958) and exchangeable potassium was determined by flame photometer after leaching soil with I.P ammonium acetate solution (Jackson, 1958)

Vegetation analysis: The phytosociology of woody vegetation was carried out by laying down quadrates of 10×10 m size randomly which was determined by species area curve method (Misra, 1968) and the running mean method (Kershaw, 1973). The trees more than 31.5 cm Cbh (circumference at brest height) *i.e* 1.37 mt above the ground, were individually measured either as sapling or as shrub and the individual less than 10.5 cm cbh were considered as seedlings (Knight, 1975). The vegetation was quantitatively analyzed for density, frequency and abundance following Curtis and Mc Intosh (1950). The relative values were determined as per Curtis (1959). The diversity index was calculated following Shannon and weiner (1963) method as **H =** S **(Ni/N) log$_2$ (Ni/N).** The concentration of dominance (Cd) was determined by Simpson's index as Cd = S (Ni/N)^2 (Simpsons, 1949). Distribution pattern was calculated as per Curtis and Cottam (1956).

RESULTS AND DISCUSSION

Soil analysis: The soil of the forest was coarse in texture *i.e* sand predominating the area. The water holding or field capacity percentage has been found to be higher for Hillock site; it varies from 72.39% (horizon A of Block-2) to 91.58% (horizon B of hillock). The pH of the soil ranged from 7.26 to 8.52 which indicate that the soil was slightly alkaline in nature. The availability of nutrient content was not enough due to low decomposition rate of organic matter and secondly removal of litter by the villagers for their daily local needs. The range of organic carbon was ranging from 0.37 (horizon c of Block-2) to 1.18 (Horizon A of block-1). The nitrogen content in different layers of soil was found ranging from 165.92 (horizon C of block-2) to 287.26 (Horizon A of Block-1). The availability of Phosphorus was raging from 33.60 (Horizon B of Block-2) to 274.40 (Horizon A of Hillock) available K was ranging from 50.40 (Horizon B of Block-2) to 544.88 (Horizon B of Hillock) (Table 1).

Phytosociological analysis: The dominant species on Hillock, Block-1 and Block-2 (Table 2) was *Acacia nilotica. Acacia nilotica* and *Acacia catechu* were showing highest IVI values of 77.63, 48.91 and25.64. Composition of tree species showed little variation, which might be due to similar climatic conditions. There were lowest number of trees (83) at Hillock, as compared to Block-1 (95) and Block-2 (99). As Hillock forest site is

Table 1. Physico-chemical properties of soil in different study sites.

Site/Horizon	Texture			Water holding Capacity (%)	Bulk density (mg/cm^3)	Organic Carbon (Mean ±S.D)	Soil pH	Available Nitrogen (kg/ha.) (Mean±S.D)	Available Phosphorous (kg/ha.) (Mean±S.D)	Available Potassium (kg/ha.) (Mean±S.D)
	Sand (%)	Silt (%)	Clay (%)							
Hillock										
Horizon A	84	8	8	91.51	1.47	0.50±0.014	7.65	185.40±74.20	274.40±33.00	453.82±7.60
Horizon B	82	8	10	91.58	1.44	0.47±0.014	8.08	180.90±43.41	272.16±18.21	544.88±3.67
Horizon C	78	6	16	88.89	1.44	0.47±0.014	8.23	180.90±59.63	217.28±3.324	520.8±2.02
Block-1										
Horizon A	88	2	10	78.82	1.69	1.18±0.084	7.45	287.26±44.63	40.32±0.340	207.76±4.06
Horizon B	88	2	10	77.28	1.52	0.62±0.058	7.26	202.75±3.870	40.32±0.436	186.76±6.20
Horizon C	88	3	9	72.93	1.66	0.94±0.077	7.69	250.37±0.514	44.80±4.022	155.68±10.05
Block-2										
Horizon A	84	8	8	72.39	1.70	0.40±0.021	8.24	170.42±5.196	38.08±8.72	77.84±2.04
Horizon B	90	0	10	76.68	1.66	0.45±0.027	8.38	177.91±39.23	33.60±1.67	50.40±0.75
Horizon C	90	2	8	74.28	1.61	0.37±0.027	8.52	165.92±2.25	40.32±0.45	52.64±2.42

Table-2. Density, Total basal cover and IVI of tree species in different study sites.

Hillock

S.N	species	Density (Ind100m $^{-2}$)	Total basal cover ($cm^2 tree^{-1}$)	IVI
1	*Acacia nilotica*	2.2	1055.0	77.63
2	*Acacia farnesiana*	1.6	718.81	59.07
3	*Acacia catechu*	1.5	661.35	54.07
4	*Propsopis juliflora*	1.9	633.04	58.11
5	*Dalbergia sissoo*	0.5	387.41	27.81
6	*Tectona grandis*	0.6	257.88	23.26

Block 1

S.N	species	Density (Ind100m $^{-2}$)	Total basal cover ($cm^2 tree^{-1}$)	IVI
1	*Acacia nilotica*	2.0	540.36	48.91
2	*Eucalyptus globules*	1.4	511.50	38.53
3	*Bauhinia racemosa*	0.9	526.59	31.92
4	*Heterophragma adenophyllum*	0.9	478.98	30.80
5	*Butea monosperma*	0.8	460.84	27.62
6	*Cassia fistula*	0.6	364.23	25.40
7	*Tectona grandis*	0.8	315.48	24.08
8	*Pongamia Pinnata*	0.7	364.08	24.34
9	*Bauhinia racemosa*	0.6	396.9	24.04
10	*Albizzia lebbek*	0.6	395.87	24.02

Block 2

S.N	species	Density (Ind100m $^{-2}$)	Total basal cover ($cm^2 tree^{-1}$)	IVI
1	*Acacia catechu*	0.8	696.6	25.64
2	*Tectona grandis*	0.7	431.64	22.74
3	*Cassia fistula*	0.8	510.77	23.83
4	*Ailanthus excels*	0.9	416.74	23.44
5	*Butea monosperma*	0.8	483.38	23.39
6	*Phoenix sylvestris*	0.8	331.6	20.89
7	*Bauhinia purpurea*	0.8	346.19	19.87
8	*Dalbergia sissoo*	0.7	366.09	19.21
9	*Acacia nilotica*	0.5	418.51	18.06
10	*Pongamia pinnata*	0.5	323.85	16.50
11	*Bauhinia variegate*	0.6	336.06	16.36
12	*Bauhinia racemosa*	0.5	340.06	15.53
13	*Pithecolobium dulce*	0.4	348.70	14.40
14	*Albizia lebbek*	0.4	270.60	13.38
15	*Eucalyptus globules*	0.4	236.25	12.82
16.	*Diospyros cordifolia*	0.3	202.31	10.03

frequently subjected to anthropogenic interferences which wiped out a number of plant species, also this interference in forest causes remarkable changes in vegetation diversity and species composition Verma *et al*. (1997). Total basal area varied from 257.88cm2100m-2 (*Tectona grandis*) to 1055.0 cm 2100m-2 (*Acacia nilotica*) for Hillock.

There was great variation in range of basal covers in the sites. Trees of Hillock showed higher girth classes which indicates this site is dominated by trees of mature age and values of basal cover fall in range reported by Singh *et al*. (1981) for silent valley. According to Saxena *et al.* (1978) the trees with higher basal area indicate the best performance of the species and lower basal area either demarcated the chance occurrence of the species or biotic disturbances of the past. Low density of trees (Table-3) indicates that tree canopy is getting open in Hillock due to disturbances.

Distribution pattern: The abundance to frequency ratio indicates that among all the study sites most of the species showed regular and random distribution pattern. The pattern of distribution depends both on physic-chemical properties of environment as well as on the biological peculiarities of the organism themselves. According to Odum (1971) in natural conditions contagious distribution is most common, preponderance of regular as well as random distribution reflects the magnitude of biotic interference such as grazing and looping in the forest sites.

Table 3. Values of total tree basal area, total tree density in different study sites of Hastinapur.

Site	Total tree basal area $cm^2 100^{-2}$	Total tree density (tree $100m^{-2}$)
Hillock	3713.49	8.3
Block-1	4354.83	9.5
Block-2	6095.35	9.9

Table 4. Distribution pattern, concentration of dominance (CD) and species diversity (H') of different forest sites of Hastinapur region.

Site	Regular	Random	Contagious	CD	H'
Hillock	50.00	50.00	-	0.035	0.014
Block-1	50.00	50.00	-	0.010	0.002
Block-2	56.25	43.75	-	0.003	0.000

Diversity (H') and concentration of dominance (CD): The values of diversity and CD in different studied sites have been presented in Table 4. The diversity values were ranging from 0.00 (Block-2) to 0.014 (Hillock) and CD values were reported from 0.003 (Block-2) to 0.035 (Hillock). These calculated values were more than 50% lower than those for tropical forest reported by Knight (1975). The possible reason for low diversity index may be aridity of the area and also possible habitat destruction which leads to less number of species and their individuals. However higher value of diversity index for Hillock can be attributed to a greater degree of repeated disturbances, which generated more hetergenous environment, giving opportunity for colonization of the varied species (Shah *et al*., 1998). Lower values of CD indicates that in this forest dominance is shared by more than one species, but these values of Cd are high in accordance with low species diversity (H'), because species diversity (H') behave inversely to the index of dominance (Odum,1971).

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